BOOK REVIEWS

Six Roads from Newton: Great Discoveries in Physics. Edward Speyer. 1994. John Wiley & Sons. 189 pp. $14.95.

Physicist John Wheeler once wrote that there are three basic approaches to science: the mole, the mutt, and the map. The mole methodically follows one step after another to reach its goal while the mutt sniffs about and drifts from one interest to another. The best approach, he said, is the map, stepping back to see the whole and the interconnections of its parts.

A map is what author Edward Speyer gives us, a road map of modern physics. In *Six Roads from Newton* he lays out a remarkably comprehensive and well-integrated overview of the great landmarks in physics. Speyer does more than provide a fine map; he also comes along for the ride, pointing out the sights like a like a good tour guide and steering us around the potholes. And the potholes are numerous, especially along some of the roads on which he dares to take us. Speyer leads us patiently and deftly around topics that may have given you troubles before, such as the dilation of time to a moving observer, the case of Schrödinger's Cat, or the possible fates of the universe. With equal grace he leads us more deeply into some common phenomena that we may have thought we understood, only to pose interesting questions that are rarely asked in physics books, or rarely questioned in lectures. In simple direct current circuits, for example, we know that electrons seek the path of least resistance; to say so has become a cliché. But how do the electrons "know" in advance which path will turn out to be the least resistive, and why don't they all then take that route? Similarly, even if we can explain how two crossed polarizers block out light, our basic explanations fail to account for the paradoxical result when a third filter is placed at an angle between the other two. These sticky problems and many others are dealt with clearly and gracefully.

The book begins by setting the stage of Newton's universe. In the first chapter Speyer takes us for a quick trip down the well-traveled road from Aristotle to Newton. Even an experienced reader who has seen these sights before will be impressed with Speyer's clear demarcations of the important points, such as Galileo's logic in demonstrating that everything falls alike, or the importance of Newton's First Law, that the conditions of uniform motion and rest are, physically, exactly the same. Having established Newton's world as a home base, Speyer takes us, in successive chapters, down the six roads: waves, fields, probability, quantum theory, and special and general relativity. His discussions are never exhaustive, but neither are they exhausting, and his style is conversational but never condescending, making the tourist feel quite comfortable along the trips.

In chapters eight and nine, Speyer revisits some especially rich and problematic sights along the Quantum Road in the context of nuclear physics and determinism. There the tourist finds excellent, terse descriptions of spin and parity, and a well-crafted section on Bell's Theorem. His lengthy discussion of determinism, indeterminism, and the need for a middle ground makes perhaps the most difficult reading of this otherwise fine little book. Not even Speyer's lucid style can shed enough light here.

A great strength of the book is that Speyer finds and clearly notes common elements and unifying principles, many of which are quite insightful. Besides using commonly held and taught themes such as conservation of energy, Speyer continually frames arguments in terms of equipartition, the idea that multiple events may be equally likely to occur, and the geodesy principle, or the principle of least action. Fermat, in the 17th century, applied this latter concept to light with great success; whether reflecting or refracting, it always follows the quickest, though perhaps not the shortest, path. Speyer also applies the principle of least action to gravitation, to water finding a path downhill, to the trajectories of objects in spacetime in general relativity, and even to causality. "Almost the whole of physics can be represented in geodetic form," he writes (p. 143). Along each road, he hints at the further elucidation of the geodesy principle later in the book. After such a buildup, Chapter 9 is a bit disappointing in the thin treatment he gives the powerful unifying concept.

Even so, Speyer's book, like a good map, shows the interconnections between topics that are usually taught and learned separately. Who would think, at least on first glance, that the anti-reflective coating on camera lenses is analogous to radioactivity? Or that water picking its way downhill is somehow connected to the refraction of light? Speyer brings an overall coherence and unity to this book, and that is the most compelling reason to read it.

The title of the final chapter is "The Road to the Stars." The gentle reader will allow that mangled metaphor because of the excellent content of the chapter, which begins with good descriptions of the size scale of our solar system and our galaxy. Consider this, for example: "Jupiter has more than twice as much mass as all the other planets and their moons put together. If you take Jupiter out of the accounting, Saturn has more than twice as much mass as all the other planets and their moons put together. That doesn't make the earth too important, except that we have the most water, the most oxygen, and the nicest weather" (p. 152). The chapter goes on through Kepler's Laws to a brilliant explanation of Newton's logic as to why planets must move in elliptical paths, and then quickly moves on to the perennial Big Questions: Where did we come from? How will it end? Does life have purpose if inanimate processes do not? Along the way he discusses the limitations of science and the penchant for productivity that characterizes our culture because of science's high position. "Our society does not make the use of the brains and talents at its disposal. Effort is made to turn every human talent to profitable account. The artist becomes a commercial artist; the musician plays routine music year after year; the writer becomes a copy man; the scientist, a weaponeer; the intellectual, a staff man; the playwrights and actors, entertainers. Nothing goes to waste, and everything goes

to waste" (p. 164).

The book concludes with a series of delightful appendices, including "What is energy" (we still do not really know), "Measurement as a creation of information," and "Physicists shouldn't take math too seriously" (a fine outline of some of the principal differences between pure mathematics and the meaning of math in science). Another brief and excellent appendix comprises a list of things that we have learned are impossible to do; "while science grows in power, it also finds more and more feats that are unachievable" (p. 169).

Physics teachers and physics majors, alike, would do well to read this book for its remarkable unifying insights. Anyone who is curious about the world would enjoy it, too. As Speyer writes, "The secret of success and enjoyment in science is not mathematical ability, nor memory for facts, nor ability to observe, valuable as these are. The decisive element is curiosity, tracking down the real questions . . . Life is more complicated if you have an active curiosity, and you are more likely to get into trouble, but it will be more fun" (pp. 22-23).

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The Kentucky Breeding Bird Atlas. Brainard Palmer-Ball, Jr. 1996. The University Press of Kentucky. Hardbound, appendices, literature cited, index, 154 black-and-white photographs by various regional photographers. Available from the University Press of Kentucky, 663 South Limestone Street, Lexington, KY 40508-4008 (800/839-6855). 380 pp. $24.95 (+$3.00 s/h).

The long-awaited *Kentucky Breeding Bird Atlas* is a solid contribution to our knowledge of breeding birds within the Commonwealth, from the western foothills of the Appalachian Mountains to the Mississippi River. This is a well-written and photographed reference formatted not unlike *The Ohio Breeding Bird Atlas*, and in fact many photographs are shared between the two atlases.

Some 162 field volunteers contributed countless hours from 1985 to 1991 documenting the occurrence of 154 species of breeding birds in Kentucky, of which 146 species were designated as "confirmed" breeders (this compares with 193 breeding birds in Ohio, of which 182 species were "confirmed"). Those species not confirmed were assigned either "probable" or "possible" breeding status. There were 727 priority census blocks, and about 70% of these recorded between 50 and 69 bird species during the atlas period. Average species diversity was greatest in the Mississippi Alluvial Plain (66.6 species per block) and lowest in the Cumberland Mountains (51.8 species per block).

Each species is represented by one page of text and a small photograph, while a facing page depicts breeding distribution, abundance maps, and analysis of block data by physiographic provinces and breeding status. Thus, for the Red-headed Woodpecker, while its breeding distribution spans the western three-quarters of Kentucky, its greatest density occurs in the extreme western quarter. Approximately 41% of priority blocks recorded this bird.

Comparisons between closely related species can be fascinating as well. While 72% of priority blocks recorded Yellow-billed Cuckoo, only 3% recorded Black-billed Cuckoo. Thus, one might expect to see or hear, on average, 24 of the former birds for each of the latter bird. Downy Woodpecker was recorded on 90% of priority blocks while Hairy Woodpecker was noted on only 54%. Surprisingly, although 11% of priority blocks recorded Chuck-wills-widow, Whip-poor-will was not much higher in frequency at only 17%. This may simply reflect typical morning censuses that missed either or both species.

Of great interest are the new insights into the breeding ranges of Kentucky's rarer species. For example, one need not drive to Florida to see Mississippi Kites as they occur in small numbers during the breeding season along the Mississippi River in riparian forests within Ballard, Carlisle, Hickman, and Fulton counties. Similarly, the Least Tern nests along gravel bars in the Mississippi River in these same counties. However, although the Red-cockaded Woodpecker is mapped in McCreary, Whitley, Pulaski, and Laurel counties, subsequent severe weather such as ice storms has reduced the total number of pairs from about 20 to less than 10. Sadly, the future of this federally endangered bird in Kentucky appears bleak.

The species accounts are not without a "gee-whiz" record or two. There is a reference to a 1952 record of a Ruby-throated Hummingbird nest placed upon an unripe peach! And few state atlases can credit so many nesting references to John James Audubon. Palmer-Ball has certainly put a wealth of breeding bird data into a readily usable format. His attention to detail is reflected in the near absence of typographical errors in the text.

In comparison to breeding bird atlases of adjacent states, however, it would have been nice to include an acetate overlay of physiographic regions that could be placed over each particular species' atlas map. A map of major cities and wildlife areas on the inner (blank) covers would have been of much value to Kentuckians and non-residents alike.

The Kentucky Breeding Bird Atlas will absorb the interest of serious birders and no doubt will foster a better awareness of the great diversity of birdlife that annually breeds in the Commonwealth. It is highly recommended.

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American Pronghorn: Social Adaptations and the Ghosts of Predators Past. John A. Byers. 1997. The University of Chicago Press, Chicago and London. 300 p. $23.95 paper.

John Byers' *American Pronghorn* is a continuum of findings and information regarding the place and creatures he has studied for fourteen years. A professor of zoology who has researched the social behavior and life history of pronghorn at Montana's National Bison Range since 1981, Byers includes everything from observations

of coyotes employing a variety of hunting strategies to capture fawns, to "conscious planning and anticipation" by feeding mothers when returning to their young, and apparent cooperation between young males during sparing bouts. This is a book for every wildlife biologist. It is more than a study of a species, it is a study of individuals as the cornerstone in the study of evolution.

Following the preface, chapters cover the scope of the author's study including: methods and materials, modal social organization, birth and hiding strategy, behavioral development, lifetime dominance ranks, reproduction, the mating system, and the issue of pronghorn behaving as if living with the ghosts of predators past. In the first chapter, Byers presents his initial interest in the hypothesis that "species-typical social cohesion and cooperation among adults is the product of early social interactions among juveniles and between juveniles and adults." Concluding the first chapter with the bold and fascinating prospect that events of the late Pleistocene particularly a suite of predators that pursued the genus Antilocapra, now extinct, drove the evolutionary selection process toward the behavior and reproductive traits we are familiar with in the American pronghorn of today.

In the chapter "The Selfish Herd: Modal Social Organization," Byers' vivid descriptions of behavior associated with dominance interaction will stimulate familiar mental images for readers with field observation experiences of their own. As well, this chapter may bring a smile to the reader's face as one envisions the often amusing antics of pronghorn social behavior. Continuing with a near exhaustive investigation into the question of why pronghorn form groups, the author concludes, "the grouping tendency of pronghorn is interpretable not in light of current selection pressures, but rather in light of past selection pressures." Again Byers makes the connection of pronghorn evolution with the pressures of formidable predators of the late Pleistocene era.

The fourth chapter provides extensive coverage regarding the likelihood of a coevolved, predator-prey relationship between pronghorn and coyote. I applaud the author's willingness to discuss the possibility that components of pronghorn consciousness guide its behavior in certain situations. Byers presents detailed descriptions and analysis of behavior associated with feeding pronghorn mothers returning to their hidden fawns. He poses, "For this specific task, pronghorn seem to have evolved a conscious planning and anticipation."

Other chapters explore factors of pronghorn behavioral development in correlation to dominance significance, and male pronghorn territoriality as an exhibition in resource defense. The author asks, "Is territoriality a demonstration in the significance of tactical space?" All are fascinating, but Byers' primary contribution to the study of pronghorn social behavior and history comes in his last chapter, where he describes the American pronghorn as a product of genetic selection and adaptation over a period of approximately 4 million years of directional selection for the avoidance of cursorial predators such as giant short-faced bear and saber-toothed cats. For pronghorn, the end-Pleistocene extinction of these formidable predators has been followed by 10,000 years of relaxed selection from cursorial predation. Thus, today we view in the American pronghorn a creature whose social adaptations and antipredator behavior are in response to the threat of ghosts of predators past.

While numerous books on the pronghorn have been published, *American Pronghorn: Social Adaptations and the Ghosts of Predators Past* is the best I've seen, containing good scientific research along with a provocative thesis, in a well-written book that will bring pronghorn to life for the reader.

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